

110639

N95-17254

575-14

31811

p. 6

CCS-MIP : LOW COST CUSTOMIZABLE CONTROL CENTRE

Christian LABEZIN, Pierre VIELCANET
CISI Aerospace Branch
13 rue Villet
F - 31029 Toulouse Cedex

ABSTRACT

The positioning and station keeping of French national satellites are among the main missions of CNES French Space Agency CNES. The related experience and skills of the Toulouse Space Centre are reknown and often required at international level for a wide range of missions. CISI, a software engineering company, has been contributing during the last 20 years to the development of the French space programmes, particularly in the field of space missions ground control segments. The CCS-MIP system, presented here, is a satellite positioning and station-keeping system designed to answer the CNES multi-mission needs, easily adaptable for a wide range of applications.

INTRODUCTION

National satellites station positioning and station keeping must cope with the following essential quality requirements :

- operational use 24 hours a day,
- safety over critical operations,
- low-cost system operations,
- system robustness and user friendliness,
- system expandability and maintainability.

Most of the systems currently in-use that meet those requirements are maintained and adapted at high costs and are not easily tuned to the actual operational needs.

No doubt that the demand for fast and easy adaptations of control systems is strong in competitive contexts like simple and recurrent space missions with limited budget, or mini-satellites programmes. There is then room in space operations for a flexible system at low recurring cost.

Through their previous developments, CNES and CISI have acquired the necessary skills for the design, the development, the adaptation and maintenance of all the components of a control centre. CISI has therefore developed for CNES the CCS-MIP satellite control centre, in accordance with the above mentioned requirements.

The specific and competitive features of the CCS-MIP, presented in this paper, are based on a tailored architecture hosting simplified basic functions, minimum specific software and extensively reused software applications.

CCS-MIP SUPPORTED FUNCTIONS

This system, designed in agreement with up-to-date mission requirements, has proven to be a sound industrial solution in terms of low cost control centre offering the following functionalities :

- acquisition of telemetry and localisation data,
- telecommands preparation and emission
- telemetry decommutation,
- telemetry display (including mimics),
- telemesure processing,
- integration of orbit and attitude restitution functions,
- logging and monitoring of application and system events.

Figure 1 below shows the main dataflows between these functions and the basic interactions with the satellite database.

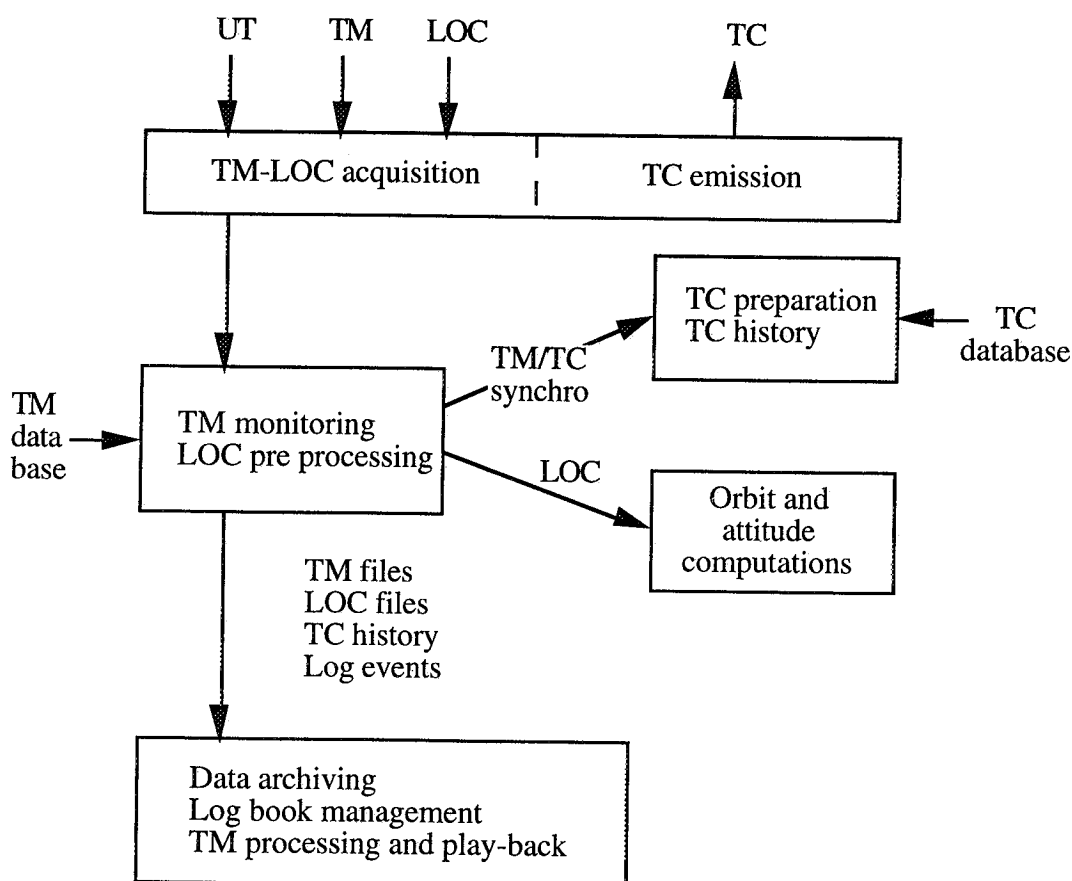


Fig. 1 : Ground control segment main functions

TECHNICAL DRIVERS

The major technical drivers have been identified in light of CNES and CISI deep experience in the development of satellite ground segments and more particularly of control centres. Due to the rapid technical evolution in this domain, the CCS-MIP has been implemented with the following design options :

- distributed computer architecture, as shown in figure 2, including real-time processors for satellite and ground stations monitoring and control, and off-line processors for operational data preparation, satellite data archiving and processing and attitude/orbit computations.
- use of a reliable and compatible hardware chosen among the first rank computer vendors
- centralisation of the processing and decrease of the number of necessary operational workstations
- use of X terminal stations

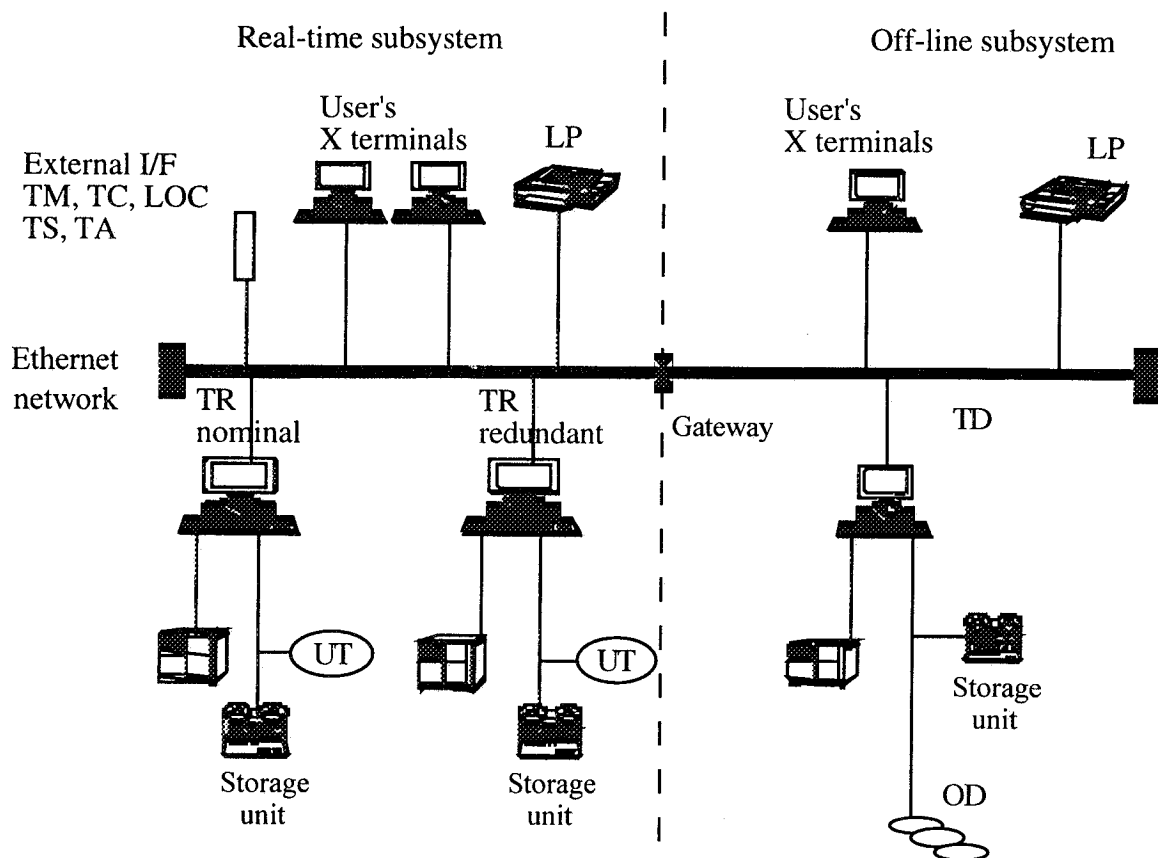


Fig. 2 : CCS-MIP generic architecture

Legend :

TR : Real-time
TD : Off-line

TA : Teleactions
TS : Telesurveillance

UT : Universal time
OD : Optical disc

- selection of stable and broadly used industrial standards for operating system (Unix system V), network protocols (Ethernet, TCP/IP, FTP) and graphical user interface (X Windows, OSF/MOTIF),
- use of mature software packages and reuse of existing software
- design of simple and guiding dialogues, self-explanatory graphical displays and on-line user-friendly help facilities,
- important parameterisation of the system, external interfaces adaptability and functional modularity,
- multi-satellite missions capability, for several satellite systems (SPACEBUS, EUROSTAR...).

These choices have resulted in the availability of a simple and customizable platform to be enhanced in order to meet most specific requirements. For instance, the needs of a mini-satellite program can be taken into account within short delays and at a very attractive cost.

CCS-MIP DEVELOPMENT METHOD

The development method used for the CCS-MIP project is depicted in figure 3. Two main stages appear in the CCS-MIP project lifecycle : the product definition and design stage with strong involvement of CNES and CISI engineers and the production stage performed by CISI. The production line refers to the stable W (hardware and software) development model.

This industrial effort has been supported by CISI Quality organisation conforming the ISO 9001 standards for studies, turn-key developments and software maintenance.

The product definition and design stage is rather innovative due to the adoption and systematic use of value analysis techniques.

Requirements screening, reviews of the specifications, trade-off on candidate architectures, assessment of available technologies and components have been performed (and iterated whenever necessary), in order to reach a valuable solution meeting the real needs under severe cost (and risk) reduction constraints.

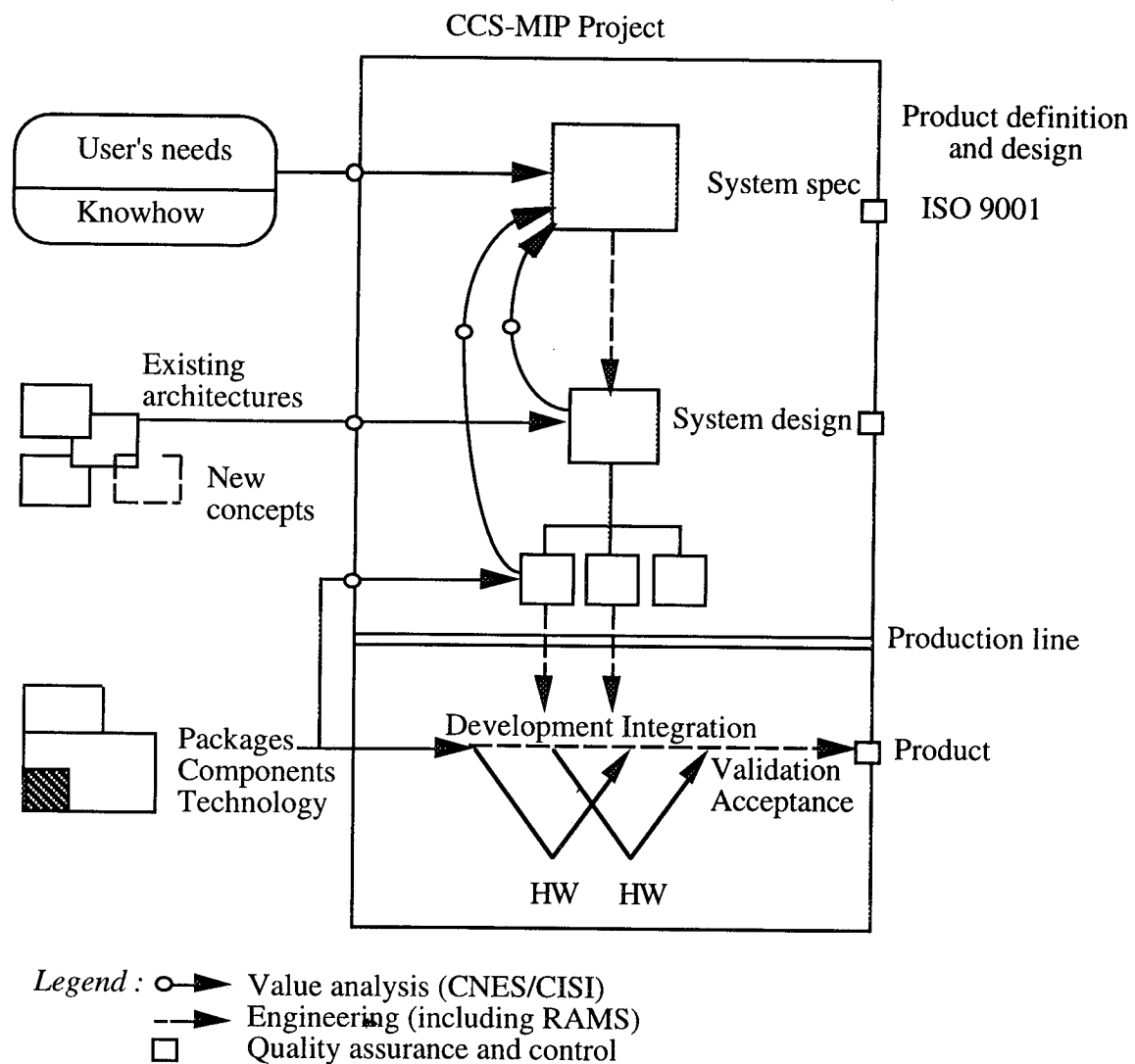


Fig. 3 : CCS-MIP development method

CONCLUSION : A REUSABLE SOFTWARE AND HARDWARE PLATFORM

The CCS-MIP answers in a very efficient way the functional objectives, operational needs, and quality requirements of the new control centre generation. In order to reach this goal, CNES and CISI analysed, understood and often simplified these requirements to get a well integrated solution meeting the user's needs. For instance, the resulting right-sized system is considerably easier to operate than its predecessors.

This early and global review of all requirements (optimal analysis approach) turned out to be very effective. This successful approach has been greatly supported by the experience and skills of the customer and contractor teams.

CCS-MIP is currently fully operational for TDF1 and TDF2 station keeping and is ready to use for the TURKSAT satellite positioning mission.

ACKNOWLEDGEMENT

We want to thank here all participants to the CCS-MIP effort, more precisely CNES engineers, initiators of the development method reported in this paper, who have greatly contributed to the definition and global design of this new control centre and CISI engineers who successfully implemented the CCS-MIP system.